

## QUANTUM AND CLASSICAL NEURAL NETWORKS: IMPLICATIONS FOR MODELING PSYCHOSOMATIC AND COGNITIVE FUNCTIONS

Dejan Raković<sup>1,3</sup> and Miroljub Dugić<sup>2,3</sup>

<sup>1</sup>Faculty of Electrical Engineering, Belgrade, Serbia and Montenegro  
rakovic@net.yu

<sup>2</sup>Faculty of Science, Kragujevac, Serbia and Montenegro  
dugic@knez.uis.kg.ac.yu

<sup>3</sup>International Anti-Stress Center (IASC), Belgrade, Serbia and Montenegro  
www.iasc-bg.org.yu

**Abstract.** *Quantum bases of consciousness* are considered with psychosomatic as well as cognitive implications of *two cognitive modes* of individual consciousness (*direct religious/creative*, characteristic of quantum-coherent *transitional and altered states* of individual consciousness, and *indirect perceptually/rationally mediated*, characteristic of classically-reduced *normal states* of individual consciousness), alongside with conditions of *transformations* of one mode into another. Tabular comparative presentation of the possibilities in *modelling cognitive and psychosomatic functions* (consciousness, perception, creativity, memorising, learning, thinking, language, emotions, transpersonal interactions) is given as well, by using classical-electrochemical hierarchical brain neural networks and quantum-holographic microwave Hopfield-like acupuncture neural networks modulated by ultralowfrequency electromagnetic fields of brainwaves, combined with quantum decoherence theory.

**Keywords:** *Quantum & Classical Hopfield-like Associative Neural Networks; Two Cognitive Modes of Individual Consciousness: Quantum (Altered/Transitional States) & Classical (Normal States); Quantum Holography & Quantum Decoherence; Comparative Modelling of Cognitive and Psychosomatic Functions (Consciousness, Perception, Creativity, Memorising, Learning, Thinking, Language, Emotions, Transpersonal Interactions).*

### 1. INTRODUCTION

The prevailing scientific paradigm considers information processing within the central nervous system as occurring through *hierarchically organised and interconnected neural networks* [1-3]. Alongside with the development of experimental techniques enabling physiological investigation of interactions of hierarchically interconnected neighbouring levels of biological neural networks, significant contribution in establishing the neural network paradigm was given by theoretical breakthroughs in this field during the past two decades [2]. It seems that this hierarchy of biological neural networks is going down subcellular *cytoskeleton* level, being according to some scientists a kind of interface between *neural* and *quantum* level [4], the last one having within the Feynman propagator version of Schrodinger equation *analogous* mathematical formalism as the Hopfield associative neural network [3].

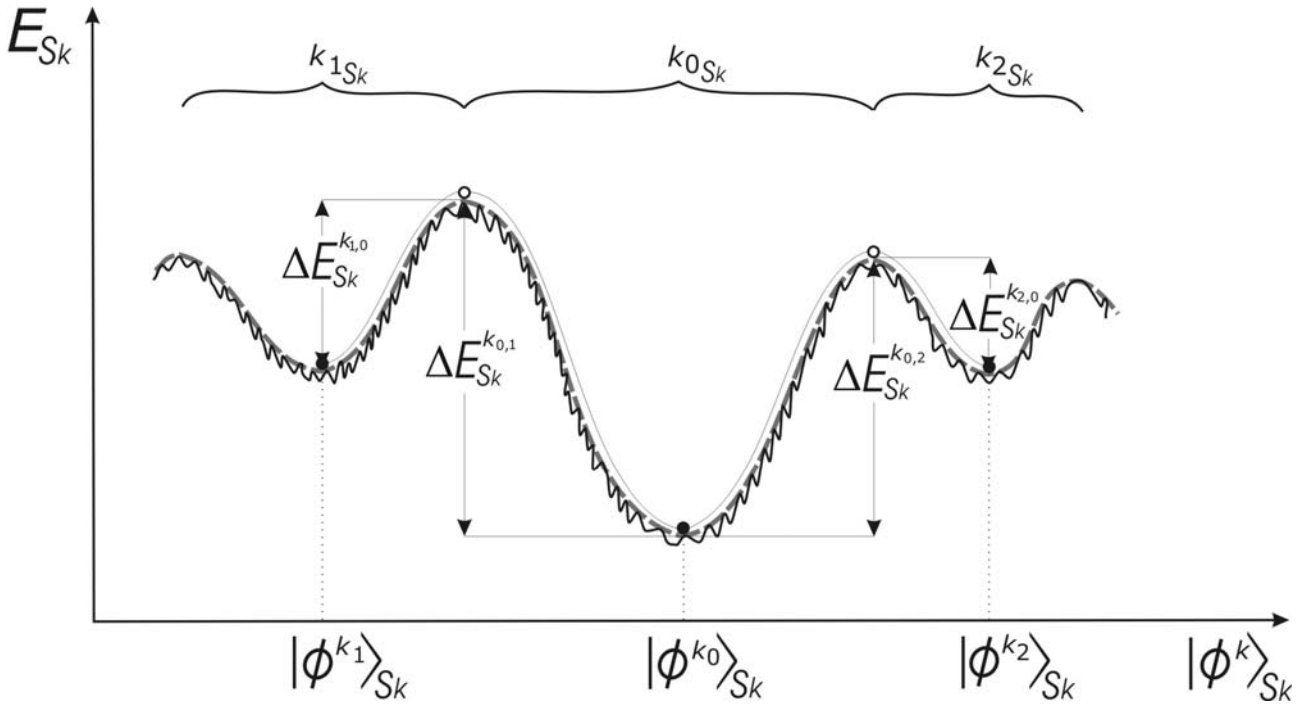
The mentioned analogy opens additional fundamental question how *quantum* parallel processing level gives rise *classical* parallel processing one, which is a general problem of relationship between quantum and classical levels within the *quantum decoherence theory* as well [5]; naturally, the same question is closely related to fundamental nature of *consciousness*, whose indeterministic manifestations of free will [6-8], and other holistic manifestations of consciousness, like transitional states [8] and altered states of consciousness [9], conscious/unconscious transitions and consciousness pervading body [10] - necessarily imply that some manifestations of consciousness must have deeper quantum origin, with significant *psychosomatic and cognitive implications* which will be elaborated in this paper.

## 2. MACROSCOPIC QUANTUM EFFECTS IN BIOPHYSICS AND QUANTUM ROOTS OF CONSCIOUSNESS: PSYCHOSOMATIC IMPLICATIONS

As demonstrated by *quantum-coherent characteristics* of the Russian-Ukrainian school of *microwave resonance therapy* (MRT) [11,12] (highly resonant microwave (MW) sensory response of the disordered organism, biologically efficient nonthermal MW radiation of the extremely low intensity, and neglecting MW energy losses alongside acupuncture meridians), the *acupuncture system* is the only *macroscopic quantum system* in our body (while brain still seems not to be [13]). And as recent investigations show that any quantum system has formal mathematical structure of *quantum-holographic associative neural network* [3] - then *memory attractors of the acupuncture network* can be treated as *psychosomatic disorders* representing EM/MW (*quantum*)*holistic records* (which might be therefore removed only holistically, supported by an extreme efficiency of the MRT therapy that consequently erases the very information of the psychosomatic disorders, cf. Fig. 1) - which represents biophysical basis of (*quantum*)*holistic local psychosomatics* [8,14,15]! An additional support that acupuncture system is really related to consciousness is provided by novel *meridian (psychoenergetic) therapies* (with very fast removing of persistent phobias, allergies and other psychosomatic disorders [16]), whose simultaneous effects of *visualisation and tapping/touching acupuncture points* might be interpreted as a "*smearing*" of *memory attractors* of the psychosomatic disorders, through successive imposing new boundary conditions in the acupuncture energy-state space during visualizations of the psychosomatic problems [15].

On the other hand, if consciousness has indeterministic characteristics (free will), it still must play essential role in the *wave function quantum collapse* [6-8], the only indeterministic property of the quantum mechanics, which has itself *manifestly open problems* of the physical nature of *nonlinear collapse* and relativistically inconsistent instantaneous action on distance of the *nonlocal collapse* of the wave function [7,8]. One possible solution of the problem of (nonlinear) collapse is proposed by Penrose [17] in *gravitationally induced objective reduction* of the wave function, while according to the *biophysical quantum-relativistic model of consciousness* [8], the similar objective reduction of the wave function might have quantum-gravitational origin in space-time microscopic *wormhole tunnels of highly noninertial microparticle interactions* in quantum measurement-like situations (fully equivalent, according to Einstein's *principle of equivalence*, to strong gravitational fields - in which opening of wormholes is predicted [18]) - implying that von Neumann's *ad hoc projection postulate* [6] *is based on quantum gravitational phenomena* [8], being on deeper physical level than nonrelativistic quantum mechanical ones. On the other hand, *nonlocality of collective consciousness* [8], as a giant space-time associative neural network with distributed individual consciousnesses (related to human bodily acupuncture EM/ionic microwave ultralowfrequency-modulated quantum-holographic neural networks [8,14,15], mutually interacting quantum-gravitationally in transitional states of individual consciousnesses [8]), might explain (apparently) *instantaneous action on distance* in (nonlinear) quantum-gravitationally induced and (nonlocally) channelled collapse by collective consciousness [8].

The remnant of these microscopic processes remained on the macroscopic level in *transitional states of individual consciousness* (as *highly noninertial processes* of the out-of-body spatio-temporal *quantum-gravitational mentally-channelled tunnelling* of the part of acupuncture EM/ionic quantum-holographic neural network [8]), presenting biophysical basis [8,15] of numerous *transpersonal communications* without space-time barriers (precognition and other esoteric phenomena and out-of-body experiences [19], experiments with prayer [20] and other nonlocal interactions [21-23]), providing also explanation for their *transitional nature and poor reproducibility*, as well as why they are most easily *mentally controlled* shortly before entering altered states of consciousness, like sleep [8] - which is in accordance with long-lasting empirical experiences of different religious/esoteric traditions of East and West [24,25], implying the *same biophysical basis* of these phenomena in all religious/esoteric traditions, as the *cognitive apparatus* of the people of all traditions is the same [26]. It should be also pointed out that necessity of *mental addressing* on the target implies *ontological personal aspect of individual human consciousness* [8], which is widely spread thesis of *Christian religious tradition* [24], with the well known *post-mortem* implications.



**Figure 1.** Schematic presentation of the memory attractors of microwave (MW/dashed line) ultralowfrequency (ULF/full line) modulated EM/ionic quantum-holographic acupuncture system/consciousness of the  $k$ -th organism in the energy-eigenstate space  $(E_{S_k}, |\phi^k\rangle_{S_k})$  of the system  $S_k$ :

$k_{0S_k}$  - basin of attraction of the ground (healthy) MW state  $|\phi^{k_0}\rangle_{S_k}$ ;  $k_{1S_k}$  and  $k_{2S_k}$  - basins of attractions of the two excited (psychosomatically disordered) MW states  $|\phi^{k_1}\rangle_{S_k}$  and  $|\phi^{k_2}\rangle_{S_k}$  (hundreds of them being in general), modulated by numerous low-amplitude ULF states of the brain hierarchical neural networks. It should be pointed out that energy surface changes gradually during the quantum-holographic MRT treatment, by decreasing the potential barriers  $\Delta E_{S_k}^{k_{1,0}}$  and  $\Delta E_{S_k}^{k_{2,0}}$  (and corresponding MRT sensory responses) of the potential wells  $k_{1S_k}$  or  $k_{2S_k}$ , to be overcome in traversing to the  $k_{0S_k}$  basin of attraction of the ground (healthy) state, when organism gradually recovers by further deepening healthy state  $|\phi^{k_0}\rangle_{S_k}$  (with weak sensory response, being already in the ground state, cf. Appendix II).

Such a picture is very close to the associative neural networks in their energy-configuration spaces, and Hebbian modification of the minima depths of the energy hypersurface, being the attractors of neural networks memory patterns  $|\phi^{k_0}\rangle_{S_k}$ ,  $|\phi^{k_1}\rangle_{S_k}$ ,  $|\phi^{k_2}\rangle_{S_k}$ , cf. Appendix I. The above approach can be generalised on quantum-holographic collective consciousness, with religious/social implications on the necessity of transpersonal spiritual quantum-holographic cleansing of all undesired side memory attractors (which, unless reprogrammed by prayer, will give rise to development of psychosomatic diseases or interpersonal conflicts in this or further generations, to which these memory patterns will be transpersonally and unconsciously temporally transferred through collective consciousness). On details see the text.

What is really anticipated in transitional states of consciousness of individual consciousness might be the *time evolved state of cosmic collective consciousness*  $|\Phi(t)\rangle_S$  (to which individual consciousness  $|\phi^k(t)\rangle_{S_k}$  has access, being the constituting part of cosmic collective consciousness) - which is quantum-mechanically described by deterministic unitary evolution governed by Schrodinger (or Feynman propagator) equation, *without collapse* [27]. In this respect, it is quite possible that *strong preferences* in individual and collective futures might exist, governed by interpersonal mental loads, as widely claimed in Eastern tradition [24], also presumably supported by contemporary mathematical discovery of the hidden Old Testament's "Bible Code" [28]. However, the anticipated state might be redefined by changing initial state of the several quantum-holographic mentally/emotionally interrelated individual consciousnesses participating in collective consciousness, thus changing anticipated preferences for individual and collective future [8]. This leaves the room for *free will*, implying that the most efficient possibility for influence on future is practising *prayer* for the others emotionally connected with (relatives, enemies, deceased), non-Schrodinger nonunitary quantum-gravitationally *mediated* by powerful and purified EM/ionic vacuum excitations of archetype macroquantum spiritual structures from religious traditions (removing in these imprinting interactions as a net effect the mutual conflicts of the two persons interacting through mediated prayer), in accordance with the Christian Orthodox hesychastic tradition [25] and Berdjajev's philosophy of freedom [29] - which represents the biophysical basis of (*quantum*)*holistic global psychosomatics* [8,15]! This implies *spiritual obligation* of everybody to reprogram his/her/its mental environment thus contributing to *complete reprogramming of collective consciousness* and "the end of history" of conflicts, giving the *full meaning* of the life of every individual disregarding his/her/its social status - which is fundamental question of *both mental hygiene and civil decency* i.e. both spiritual and civil morality.

On the other hand, *spontaneous transpersonal communications* with information exchange in transitional states of individual consciousness have evidently *negative effects*, as necessarily give rise to *global increase of psychosomatic loads* on the level of macroscopic quantum spatio-temporal network of *collective consciousness* [30] - while *other methods of personality integration*, like *meditation* [9] (as an *altered state of consciousness*, contributing to accelerated integration of conscious and unconscious levels of personality [8,15]) or *deep psychotherapeutic practices* [31] (oriented to recognition of the origin of unconscious conflict and its ascending to conscious level), or *meridian (psychoenergetic) therapies* [16] (with accelerated removing of phobias, allergies, and other psychosomatic disorders, through "*smearing*" of *memory attractors* of psychosomatic disorders during successive touching of the chosen acupuncture points and accompanied visualisation of the psychosomatic disorders [15]) - have holistic character of the *local psychosomatics and temporary effects on the level of individual consciousness* [8,15], as nonreprogrammed interpersonal conflicts within the others cause their (unconscious) *transpersonal reinducement* within the first person (thus working in vein on individual personality integration!) in transitional states of consciousness of these persons, thus *reinducing previous loads of collective consciousness*.

At the same time, analogy between mathematical formalisms of *Hopfield's associative neural network* and *Feynman's propagator version of the Schrodinger equation* [3], implies that *collective consciousness is possible ontological property of the physical field itself* [8,15] with various microquantum and macroquantum (both nonbiological and biological) excitations, which is widely spread thesis of *Eastern esoteric/religious traditions* [32].

So it seems that the *whole psychosomatics is quantum hologram*, both on the level of individual and collective consciousness, which resembles on Hinduistic relationship Brahman/Atman, as wholeness and its part which holds information about the wholeness [24]. The mentioned quantum-holographic picture also implies that quantum-holographic hierarchical parts hold information on wholeness, enabling subtle quantum-holographic fractal coupling between different hierarchical levels, which is presumably supported by novel discovery of quantum-holographic influence of the language communication on the expression of genes, as well as of the fractal-information coupling of different hierarchical levels in Nature [33]. This also implies quantum-holographic coupling of the acupuncture and genetic levels, with mutual *quantum-informational control of ontogenesis and morphogenesis*, starting from the first fertilised cell division which initialises differentiation of the acupuncture system of (electrical synaptic) "gap-junctions" [34].

In this context, it might be said that *three front lines* of psychosomatic medicine exist: (a) the first one is *spirituality*, where prayer for the others mentally/emotionally involved erases for good mutual memory attractors on the level of collective consciousness; (b) the second one is *traditional holistic Eastern medicine and deep psychotherapeutic techniques*, whose efforts temporarily erase memory attractors on the level of acupuncture system/individual consciousness, and prevent or alleviate their somatization, as a consequence of the indolence on the first level; (c) the third one is *conventional Western medicine*, whose activities through immunology, pharmacology, biomedical diagnostics, and surgery, hinder or soothe somatic consequences of the carelessness on the first two levels. It should be stressed, that *necessary* activities on the second and third levels, with *neglect* of the first level, have a consequence of *further transfer* of memory attractors on the level of individual and collective consciousness in this and further generations, thus accumulating quantum-holographic loads which afterwards cause not only illnesses, but also interpersonal fights, wars, and other troubles.

### 3. QUANTUM AND CLASSICAL NEURAL NETWORKS FOR MODELING TWO MODES OF CONSCIOUSNESS: COGNITIVE IMPLICATIONS

Accordingly, we may speak of *two cognitive modes* of individual consciousness [8,15]: the quantum-coherent direct one (religious/creative, in altered and transitional states of consciousness) and the classically-reduced indirect one (perceptually/rationally mediated, in normal states of consciousness) - to which theoretical methods of associative neural networks and quantum neural holography [3] (cf. Appendix I) combined with quantum decoherence theory [35] (cf. Appendix II) might be applied.

The *direct cognitive mode* of individual consciousness may be related to weakly coupled consciousness-environment communication, within the nonlocal quantum-holographic/quantum-gravitational space-time network of collective consciousness (characteristic of quantum-coherent *transitional and altered states of individual consciousness*, in religious-esoteric transpersonal communications, of the quantum-gravitationally tunnelled quantum-holographic-Hopfield-like electromagnetic/ionic out-of-body displaced part of the acupuncture network of individual consciousness, with the mentally addressed nonlocal environment-target, including anticipation in intuition, precognition, and deep creative insights [8,15] - being after quantum collapsing in classical/normal state of consciousness, through restituted strong coupling of quantum-holographic-consciousness-contents with the body, further subjected to indirect language/artistic/scientific filtering through extended reticular-thalamic activated system, ERTAS [1], thus classically-reducing initially obtained direct quantum-coherent information content - so explaining *generally poor* informational rationalisation of the initial full quantum-holographic awareness of spiritual/religious mystical experiences).

The *indirect cognitive mode* of individual consciousness may be related to strongly coupled consciousness-body-environment communication via space-time limited perceptual sensations, further processed by classical/electrochemical hierarchical neural networks and rationally filtered in conscious content by approximate empirical/artistic/scientific concepts dependent of cultural/scientific tradition and education of the inhabitants of some society (characteristic of classically-reduced *normal states of individual consciousness* in everyday communications, additionally *filtered* and amplified by ERTAS system - and afterwards transcribed in conscious content of the quantum-informational acupuncture network of individual consciousness, via brainwaves' EM fields every  $\sim 0.1$  s - so generating normal "stream of consciousness" [3]).

More concretely, in approximation of almost non-interacting individual consciousnesses, the state of collective consciousness is  $|\Phi\rangle_S \sim \prod_k |\phi^k\rangle_{S_k}$ . Here the quantum-coherent state of the  $k$ -th individual

consciousness,  $|\phi^k\rangle_{S_k} = \sum_i c_{k_i} |\phi^{k_i}\rangle_{S_k}$ , is described by superposition of its all possible states ( $\phi^{k_i}$ ),

which after quantum collapsing in classically-reduced state gives rise to stochastic state described by

density matrix  $\tilde{\rho}_{S_k}^k = \sum_i |c_{k_i}|^2 |\phi^{k_i}\rangle_{S_k S_k} \langle \phi^{k_i}|$ , with probabilities  $|c_{k_i}|^2$  of the realisation of one of the

classically decoherent states  $|\phi^{k_i}\rangle_{S_k}$  - in quantum measurement-like process upon the initial quantum-coherent state  $|\phi^k\rangle_{S_k}$ , cf. Appendix II. The time evolution  $|\phi^k(t)\rangle_{S_k}$  of the quantum-coherent state of  $k$ -th individual consciousness might be described in Feynman's representation by quantum-holographic Hopfield-like neural network [3,15], while the time evolution  $\widehat{\rho}_{S_k}^k(t)$  of the classically-reduced stochastic state of  $k$ -th individual consciousness might be described by classical Hopfield-like neural network [2,15], cf. Appendix I, represented by changes in the shape of the potential hypersurface in the acupuncture energy-state space  $(E_{S_k}, |\phi^k\rangle_{S_k})$ , cf. Fig. 1.

These cognitive modes of individual consciousness are presumably interchanged by periodicity of  $\sim 2$ -hour *ultradian rhythm*, both in waking and sleep states [36], which according to quantum-relativistic model of consciousness [8] might be the cause of corresponding changes in subjective sense in transitions between normal and altered states of consciousness (with dilations of subjective time sense and mixing of normally conscious and unconscious contents). According to this model, *consciousness* is subtle internal display in the form of EM component of the acupuncture EM/ionic system, as *microwave/ultralowfrequency (MW/ULF) modulated quantum-holographic Hopfield-like neural network*, in which complete information is continuously coded (both normally conscious and unconscious) from brain's neural networks (where synaptic coding is still electrochemical one), mediated by brainwaves as an interface. Then *altered states of consciousness* (REM sleep phase, hypnosis, meditation, hallucinogenic states, some psychopathological states, clinical death, ...) are consequence of an out-of-body displacement of the part of EM/ionic acupuncture system (when its "embedded" EM component of ionic currents propagates through slightly nonhomogeneous low-dielectric weakly ionised out-of-body gaseous structure) with ERTAS system switched off, while *normal states of consciousness* (normal waking state, non-REM sleep phase, ...) are realised without these displacements (when EM component of ionic currents propagates through strongly nonhomogeneous high-dielectric body tissues). It should be specially pointed out that in altered states of consciousness the EM component of ionic currents propagates both through the body and the displaced part of the ionic acupuncture system, but conscious contribution of the first ones is negligible due to the overlapping of non-amplified contents, while the second ones give rise to conscious contribution due to good temporal differentiation of the same contents - and hence it seems that condition for strong manifestation of altered states of consciousness is both switched off ERTAS and generation of the displaced (out of body) part of acupuncture EM/ionic system [8]. This is typically fulfilled in *altered states of consciousness*, when model also predicts mixing of normally conscious and unconscious contents, due to relativistic Doppler mapping of the "objective" brainwave power spectrum (as a superposition of  $\gamma$ ,  $\beta$ ,  $\alpha$ ,  $\theta$ , and  $\delta$  bands) on the "subjective" zero-frequency peak - this being the reason for a role of REM-dreaming (and meditation) in integration of normally conscious and unconscious contents (otherwise divided by normal daily brain functioning) around one dominant associative "ego" state, and consequently *personality growth and alleviation of emotional conflicts* [8].

The above-mentioned division in *two cognitive modes* of individual consciousness, *quantum-coherent direct one* (in religious/creative altered and transitional states of consciousness) and *classically-reduced indirect one* (in perceptually/rationally mediated *normal states of consciousness*) - is still non-quite sharp.

Namely, in religious/creative *altered and transitional states of consciousness*, quantum-coherent direct modus might be *transformed* into classically-reduced indirect mode, in the case of strong out-of-body interaction consciousness-environment, with quantum-reduced out-of-body *extrasensory perception of the mentally addressed environment*, which transforms out-of-body displaced part of individual consciousness from nonstationary quantum-coherent state of the quantum-holographic Hopfield-like neural network in the above described stationary classically-reduced stochastic state of the classical Hopfield-like neural network. After interruption of this interaction, with returning out-of-body displaced part of individual consciousness in quantum-gravitationally mentally-channelled tunnelling of the displaced part of individual consciousness upon its body, this information is further transcribed through (MW/ULF) EM interaction acupuncture system/nervous system and afterwards language/artistic/scientific filtered by the brain hierarchical neural ERTAS system (with accompanied

brainwave "frequency uprising" thought from lower-frequency ULF ( $\delta, \theta$ ) unconscious form of subliminal thought to higher-frequency ULF ( $\alpha, \beta, \gamma$ ) conscious form, with significant unconscious-contextual cognitive/linguistic and psychotherapeutic implications [37], cf. Table 1). It should be also pointed out that mentioned (MW/ULF) EM *acupuncture system/nervous system interaction* has its threshold potential of the nervous electrochemical synapses (in contrast to practically non-existing threshold potential of the acupuncture electrical "*gap-junction*" synapses [8,14], which makes bodily acupuncture system an extremely sensitive quantum sensor) and therefore filters all thus extrasensory obtained information below nervous threshold potential, preventing them to be additionally language/artistic/scientific articulated by the brain hierarchical neural ERTAS system - enabling further processing of only that information which is sufficiently "emotionally coloured" i.e. has sufficient critical depth of MW/ULF EM acupuncture memory attractors (cf. Fig. 1), or has greater general acupuncture energetic potential (inborn or gained through various traditional techniques of stimulation, deep breathing, relaxation, meditation or prayer).

On the contrary, the reverse *nervous system/acupuncture system interaction* - effective in transcription of language/artistic/scientific articulated brain information into conscious content of the acupuncture network of individual consciousness, mediated by ULF EM field of brain neural activities every  $\sim 0.1$  s thus generating normal "stream of consciousness" and ULF-modulating acupuncture MW-memory attractors - is going *without threshold limits*. In this context, in perceptually/rationally mediated *normal states of consciousness*, the classically-reduced indirect mode can be *transformed* into quantum-coherent direct mode of individual consciousness after ULF EM transcription of the brain articulated information into conscious content during interaction nervous system/acupuncture system, in the case of short-lasting *nonstationary excitations of acupuncture system* in interactions with strongly changing environment (cf. Appendix II) - like MRT or other types of acupuncture stimulation, inhalation of the air ions in deep yoga breathing and their redistribution over acupuncture system, different meditative and other psycho-muscular relaxation techniques, stressful situations, transitional and altered states of consciousness [14] - which transform the acupuncture system from stationary classically-reduced stochastic state of classical Hopfield-like neural network into nonstationary quantum-coherent state of quantum-holographic Hopfield-like neural network, which afterwards collapses into next stationary classically-reduced state. This can be also a model of (most frequently) perceptually/rationally induced strong intentional classical/quantum/classical stationary/nonstationary/stationary backward hierarchical (inter)actions nervous/acupuncture/nervous systems - i.e. model of *free will*!

#### 4. CONCLUSION

In this paper, *quantum bases of consciousness* are considered with psychosomatic as well as cognitive implications of *two cognitive modes of individual consciousness*: the quantum-coherent direct one and the classically-reduced indirect one, alongside with conditions of transformations of one mode into another - to which theoretical methods of associative neural networks and quantum neural holography, combined with quantum decoherence theory, might be applied.

The *direct cognitive mode* of individual consciousness might be related to weakly coupled consciousness-environment communication, within the nonlocal quantum-holographic/quantum-gravitational Hopfield-like space-time network of collective consciousness (characteristic of quantum-coherent transitional and altered states of individual consciousness in religious-esoteric transpersonal communications, including anticipation in intuition, precognition, and deep creative insights), while the *indirect cognitive mode* of individual consciousness might be related to strongly coupled consciousness-body-environment communication via space-time limited perceptual sensations, further processed by classical/electrochemical hierarchical neural networks and rationally filtered in conscious content by approximate empirical/artistic/scientific concepts dependent of cultural/scientific tradition and education of the inhabitants of some society (characteristic of classically-reduced normal states of individual consciousness in everyday communications - being *generally poorer* in information than full quantum-holographic awareness of spiritual/religious mystical experiences). In Table 1 comparative presentation of the possibilities in *modelling cognitive and psychosomatic functions* (consciousness, perception, creativity, memorising, learning, thinking, language, emotions, and transpersonal interactions) is given as well.

**Table 1.** Comparative presentation of the possibilities in modeling cognitive and psychosomatic functions by combined using of classical-electrochemical hierarchical brain neural networks and quantum-holographic microwave (MW) Hopfield-like acupuncture neural networks modulated by ultralowfrequency (ULF) electromagnetic (EM) fields of brainwaves.

FUNCTION	CLASSICAL-ELECTROCHEMICAL HIERARCHICAL BRAIN NEURAL NETWORKS	QUANTUM-HOLOGRAPHIC MW HOPFIELD-LIKE ACUPUNCTURE NEURAL NETWORKS MODULATED BY ULF EM FIELDS OF BRAINWAVES
CONSCIOUSNESS	<ul style="list-style-type: none"> <li>• hierarchical extended reticular-thalamic activated system ERTAS (amplitude and frequency modulation) [1,37]</li> </ul>	<ul style="list-style-type: none"> <li>• biophysical quantum-holographic nature of individual consciousness, related to MW/ULF-modulated EM field of the acupuncture system [8,14,15]</li> <li>• biophysical quantum-holographic nature of individual consciousness, related to the unified physical field [8,15]</li> <li>• quantum-coherent transitional and altered states of consciousness (REM sleep, meditation, hypnosis, hallucinogenic states, out-of-body clinical death experiences, ...) [8,15]</li> <li>• classically-reduced normal states of consciousness [8,15]</li> <li>• free will as (most frequently) perceptually/rationally mediated strong intentional classical/quantum/classical backward hierarchical (inter)actions nervous/acupuncture/nervous systems [8,15]</li> </ul>
PERCEPTION	<ul style="list-style-type: none"> <li>• indirect (perceptually-rationally modulated, selected and rationally-filtered classical-electrochemical) communication of hierarchical brain neural networks with nearby environment (image, sound, olfaction, flavour, tactile) [1-3]</li> </ul>	<ul style="list-style-type: none"> <li>• direct (extrasensory transpersonal religious-creative quantum-holographic) communication of the acupuncture network of individual consciousness with mentally-addressed target within quantum-gravitational network of collective consciousness, in transitional and altered states of consciousness - which collapses into one of quantum alternatives by returning into normal state of consciousness under the "pressure" of the bodily macroscopic environment, thus becoming classical indirect language/artistic/scientific filtered information [8,15]</li> </ul>
CREATIVITY	-	<ul style="list-style-type: none"> <li>• anticipating mentally controlled quantum-holographic states, in transitional and altered states of consciousness [8,15]</li> <li>• intense associative coupling of conscious and unconscious contents in altered states of consciousness [8,15]</li> </ul>
MEMORIZING	<ul style="list-style-type: none"> <li>• spatial synaptic activation (short-term and long-term memory) [1-3]</li> </ul>	<ul style="list-style-type: none"> <li>• ULF memorising for various lower-frequency (<math>\delta, \theta</math>) unconscious levels and higher-frequency (<math>\alpha, \beta, \gamma</math>) conscious levels [8,37]</li> <li>• spatial memorising in the form of quantum-holographic attractors of the acupuncture network (as the basis of holistic psychosomatic disorders) - combined with EM interactions with hierarchical neural ERTAS networks [8,15]</li> </ul>
LEARNING	<ul style="list-style-type: none"> <li>• nonlinear classical-electrochemical brain neural networks (generalisation) [1-3]</li> </ul>	<ul style="list-style-type: none"> <li>• nonlinear quantum-holographic acupuncture networks (generalization), with distribution of the generalized information through EM interaction of the acupuncture network with hierarchical neural ERTAS networks [8,15]</li> <li>• nonlocal distribution (of locally learned) information in hierarchical neural ERTAS networks through ULF brainwaves (before habituation) [8,15,37]</li> </ul>



**Table 1** (continued)

<p><b>THINKING</b></p>	<ul style="list-style-type: none"> <li>• emotional and language modulation of information [1-3]</li> <li>• information processing in associative secondary and tertiary cortical regions, and in prefrontal cortex [1-3]</li> </ul>	<ul style="list-style-type: none"> <li>• creative aspects of thinking in transitional and altered states of consciousness [8,15]</li> <li>• "frequency uprising" thought, under the influence of ERTAS-amplification, from lower-frequency ULF (<math>\delta,\theta</math>) unconscious form of subliminal thought to higher-frequency ULF (<math>\alpha,\beta,\gamma</math>) conscious form [8,37]</li> </ul>
<p><b>LANGUAGE</b></p>	<ul style="list-style-type: none"> <li>• hierarchical primary, secondary, and tertiary cortical areas, for semantic/pragmatic/syntactic organisation [1-3,46]</li> </ul>	<ul style="list-style-type: none"> <li>• ULF lower-frequency (<math>\delta,\theta</math>) unconscious mother-tongue and contextual second language learning, and higher-frequency (<math>\alpha,\beta,\gamma</math>) conscious school second language learning [8,37]</li> <li>• Uniqueness of quantum-holographic codes of the genes, acupuncture system, consciousness, and language [15,33,34,37]</li> </ul>
<p><b>EMOTIONS</b></p>	<ul style="list-style-type: none"> <li>• amplitude and frequency ERTAS modulation [1,37]</li> </ul>	<ul style="list-style-type: none"> <li>• deepen quantum-holographic attractors of the acupuncture system, combined with EM interactions with hierarchical neural ERTAS networks [8,15,37]</li> <li>• holistic psychotherapeutic implications [8,15,37]: REM-sleep and meditation (integration of conscious and unconscious personality levels); autogenic training (unconscious memorising of autosuggestive contextual anti-stress messages); deep psychotherapeutic techniques (recognition of unconscious conflict and its ascending to conscious level, with further integration of personality); meridian (psycho)energetic therapies ("dissolving" of the memory attractors of psychosomatic disorders, through successive imposing of novel boundary conditions by tapping/touching acupuncture points with simultaneous visualisations of the associative chain of psychosomatic disorders); transpersonal Christian-religious techniques (bi-directional and simultaneous reprogramming of the quantum-holographic acupuncture memory attractors of the persons involved, through spiritually mediated hesychastic prayer in transitional states of consciousness of the praying person, as the only way for final reprogramming of collective consciousness/"motor of history" and changing of the preferences for individual and collective future)</li> </ul>
<p><b>TRANSPERSONAL INTERACTIONS</b></p>	<p>-</p>	<ul style="list-style-type: none"> <li>• short-range interactions by MW/ULF EM induction (nonverbal hypnosis and healer diagnostics and/or ionic transfer (healer/healee), with accompanied quantum-holographic acupuncture-genetic control of ontogenesis and morphogenesis [8]</li> <li>• long-range global ULF EM interactions at the end of altered states (Jung's collective unconsciousness) [8]</li> <li>• long-range directional mentally-addressed quantum-gravitational wormhole tunnelling of the displaced part of MW/ULF EM/ionic acupuncture system, in quick transitional states of consciousness ("astral projections" of consciousness on organic and inorganic "targets", without spatio-temporal limitations; "spiritual" diagnostics and healing, with accompanied quantum-holographic acupuncture-genetic control of ontogenesis and morphogenesis) [8,15]</li> </ul>

## APPENDIX I: ON PARALLELS BETWEEN CLASSICAL AND QUANTUM HOPFIELD-LIKE NEURAL NETWORKS

Hopfield's *classical neural networks* has been extensively studied, simulated and used in *cognitive neuroscience* too [2]. However, it has also been shown recently that Hopfield's classical neural network model is mathematically analogous to Feynman's propagator version of the quantum theory [38]. Hence, in this appendix the formal *informational parallelism* between classical and quantum Hopfield-like neural networks will be overviewed.

In the model of *Hopfield's classical neural network*, emergent collective computation is regulated by minimization of the Hamiltonian energy function [2]

$$H = -\frac{1}{2} \sum_{l=1}^{N_k} \sum_{j=1}^{N_k} J_{lj}^k q_l^k q_j^k = -\frac{1}{2} \sum_{l=1}^{N_k} \sum_{j=1}^{N_k} \sum_{i=1}^{P_k} q_l^{k_i} q_j^{k_i} q_l^k q_j^k \quad (I.1)$$

where  $q_l^k$  is the actual collective activity of the  $l$ -th neurone (out of  $N_k$  neurones in the  $k$ -th network  $K_k$ ), while  $q_l^{k_i}$  is the contribution of the activity of the  $l$ -th neurone when taking part in encoding the  $k$ -th memory pattern (out of  $P_k$  existing memory patterns in the neural network  $K_k$ ). The process of gradient-descent of this energy function is a result of a web of interactions between the *system of neurones* described by vector  $\mathbf{q}^k$  (with elements  $q_l^k$ ) and the system of *synaptic connections*, described by the *memory matrix*  $\mathbf{J}^k$  (with elements  $J_{lj}^k$ ), which is manifested with appearance of  $P_k$  minima (*memory attractors*) in the energy-state hyperspace of the neural network  $K_k$  (cf. Fig. 1).

Thus, in the model of Hopfield classical neural network, Hebbian dynamic equation for *neuronal activities*

$$q_l^k(t_2 = t_1 + \delta t) = \sum_{j=1}^{N_k} J_{lj}^k q_j^k(t_1) \quad \text{or} \quad \mathbf{q}^k_{out}(t_2) = \mathbf{J}^k \mathbf{q}^k_{in}(t_1) \quad (I.2)$$

and dynamic equation for *synaptic connections* (weights)

$$J_{lj}^k = \sum_{i=1}^{P_k} q_l^{k_i} q_j^{k_i} \quad \text{or} \quad \mathbf{J}^k = \sum_{i=1}^{P_k} \mathbf{q}^{k_i} \mathbf{q}^{k_i T} \quad (I.3)$$

exhibit a joint *classical parallel-distributed information processing system*. This is one of the simplest algorithms useful for theoretical brain modelling [2].

Equation (I.1) is *global* (variational) description, while system of equations (I.2-3) is *local* (interactional) description of the learning of input-data vectors  $\mathbf{q}^{k_i}$ , in Hopfield's classical neural network  $K_k$ . The corresponding neuronal activities can be inserted in the system of neurons  $\mathbf{q}^k$  iteratively, or can be put in the very beginning simultaneously into the Hebb memory matrix  $\mathbf{J}^k$  which contains all synaptic weights  $J_{lj}^k$ .

Equations (I.2-3) can be rewritten in *continuous form* incorporating spatio-temporal description of neuronal and synaptic activities:

$$\mathbf{q}^k_{out}(\mathbf{r}_2, t_2) = \iint \mathbf{J}^k(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) \mathbf{q}^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 dt_1 \quad (I.4)$$

$$\mathbf{J}^k(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) = \sum_{i=1}^{P_k} q^{k_i}(\mathbf{r}_2, t_2) q^{k_i T}(\mathbf{r}_1, t_1) \quad \text{or} \quad \mathbf{J}^k(\mathbf{r}_2, \mathbf{r}_1) = \sum_{i=1}^{P_k} q^{k_i}(\mathbf{r}_2) q^{k_i T}(\mathbf{r}_1) \quad (I.5)$$

The *memory recall* in Hopfield's classical neural network is done by input-output transformation  $\mathbf{q}^k_{out} = \mathbf{J}^k \mathbf{q}^k_{in}$ , or in developed form

$$\mathbf{q}^k_{out}(\mathbf{r}_2, t_2 = t_1 + \delta t) = \int \mathbf{J}^k(\mathbf{r}_2, \mathbf{r}_1) \mathbf{q}^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 = \int \left[ \sum_{i=1}^{P_k} q^{k_i}(\mathbf{r}_2) q^{k_i T}(\mathbf{r}_1) \right] \mathbf{q}^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 \quad (I.6)$$

From equation (I.6) it is obvious that if the input vector  $\mathbf{q}^k_{in}$  is most similar to some of the previously memorised vectors, say  $q^{k_1}$  (and simultaneously almost orthogonal to all other memory vectors  $q^{k_i}$ ,  $i \neq 1$ ), then the output vector  $\mathbf{q}^k_{out}$  converges to the memory pattern-qua-attractor  $q^{k_1}$ , i.e. Hopfield's classical neural network  $K_k$  *associatively recognises* the vector  $q^{k_1}$ .

Haken has shown that introduction of biologically more plausible *neuronal oscillatory activities* gives richer dynamics of the neural network [39], with Hopfield's classical neural net real-valued variables replaced by the *complex-valued* ones (similarly to quantum variables, although in contrast to thus conveniently modified classical formalism, the complex-valued quantum formalism is essential). A step further is done with *quantum generalization* of Hopfield's neural network: Sutherland's *holographic neural network* [40] and, equivalent to it, Peruš's model of *Hopfield-like quantum neural network* [3]. In this appendix we shall review *Peruš's model*, based on the direct mathematical correspondence between classical neural (left) and quantum variables (right) and corresponding Hopfield-like classical and quantum equations, respectively:

$$\mathbf{q}^k \Leftrightarrow \phi^k, \quad q^{k_i} \Leftrightarrow \phi^{k_i}, \quad \mathbf{J}^k \Leftrightarrow G^k$$

$$(I.4) \Leftrightarrow (I.7), \quad (I.5) \Leftrightarrow (I.8), \quad (I.6) \Leftrightarrow (I.9)$$

The equations in pairs are *mathematically equivalent*, implying similar *collective dynamics of the neural and quantum systems*, in spite of different nature of the set of neurons ( $\mathbf{q}^k$ ) and their memory synaptic connections ( $\mathbf{J}^k$ ) in the neural network  $K_k$ , on the one hand, and wave functions ( $\phi^k$ ) and their propagator connections ( $G^k$ ) in the quantum system  $S_k$ , on the other hand.

So, in Peruš's model of the *Hopfield-like quantum neural network* [3], dynamic equation for the *wave function of the k-th quantum system*  $S_k$

$$\phi^k_{out}(\mathbf{r}_2, t_2) = \iint G^k(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) \phi^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 dt_1 \quad \text{or} \quad \phi^k_{out}(t_2) = G^k \phi^k_{in}(t_1) \quad (I.7)$$

and dynamic equation for the *propagator of the quantum system*  $S_k$

$$G^k(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) = \sum_{i=1}^{P_k} \phi^{k_i}(\mathbf{r}_2, t_2) \phi^{k_i}(\mathbf{r}_1, t_1)^* \quad \text{or} \quad G^k(\mathbf{r}_2, \mathbf{r}_1) = \sum_{i=1}^{P_k} \phi^{k_i}(\mathbf{r}_2) \phi^{k_i}(\mathbf{r}_1)^* \quad (I.8)$$

exhibit a joint *quantum parallel-distributed information processing system*, where  $\phi^{k_i}$  are *eigen wave functions* of the quantum system  $S_k$ . So  $\phi^{k_i}$  represents the *memory state*, and the propagator  $G^k$  constitutes the *memory* of thus informationally interpreted *quantum system*  $S_k$ ! (Actually, so defined propagator  $G^k$  is related to the usually used Green function propagator  $\bar{G}^k$ , by equation  $G^k = -i\bar{G}^k$  [38].)

The *memory recall* in Hopfield-like quantum neural network is done by input-output transformation  $\phi^k_{out} = G^k \phi^k_{in}$ , or in developed form

$$\phi^k_{out}(\mathbf{r}_2, t_2 = t_1 + \delta t) = \int G^k(\mathbf{r}_2, \mathbf{r}_1) \phi^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 = \int \left[ \sum_{i=1}^{P_k} \phi^{k_i}(\mathbf{r}_2) \phi^{k_i}(\mathbf{r}_1)^* \right] \phi^k_{in}(\mathbf{r}_1, t_1) d\mathbf{r}_1 \quad (I.9)$$

i.e. in the other form (where one can recognise the *quantum superposition principle*, i.e. the development of the wave function  $\phi^{k}_{out}$  over the wave functions  $\phi^{k_i}$  )

$$\phi^{k}_{out}(\mathbf{r}, t) = \sum_{i=1}^{P_k} c_{k_i}(t) \phi^{k_i}(\mathbf{r}) = \sum_{i=1}^{P_k} \int [\phi^{k_i}(\mathbf{r})^* \phi^{k}_{in}(\mathbf{r}, t) d\mathbf{r}] \phi^{k_i}(\mathbf{r}) \quad (I.9')$$

From equations (I.9) and (I.9') it is obvious that if the input wave function  $\phi^{k}_{in}$  is most similar to some of the previously memorized wave function, say  $\phi^{k_1}$  (and simultaneously almost orthogonal to all other memory eigen wave functions  $\phi^{k_i}$ ,  $i \neq 1$ ), then the output wave function  $\phi^{k}_{out}$  converges to the memory pattern-qua-attractor  $\phi^{k_1}$ , i.e. Hopfield-like quantum neural network  $S_k$  *associatively recognizes* the eigen wave function  $\phi^{k_1}$ .

Or translated into orthodox language of the quantum physics [38], in the above example the propagator  $G^k$  represents the *projector* onto the wave subspace/state  $\phi^{k_1}$ , i.e. makes *reduction* (collapse) of the wave function  $\phi^{k}_{in}$  of the quantum system into the eigen state  $\phi^{k_1}$ . Naturally, the collapse of the wave function of the *quantum processor* (not only of the hereby considered associative quantum memory) is also the final phase of the quantum computers as a network of quantum neurons (qubits) [41] - as well as the *quantum decoherence within the k-th consciousness* [13], presumably through the brain frontolimbic [1] process of the *selection and amplification* of the one out of many (parallel processed subliminal ULF lowerfrequency) unconscious pieces of information toward (ULF higher-frequency) conscious thought in *normal states of consciousness* [8].

Hopfield-like quantum neural networks are better than the classical ones because of the quantum phase differences which improve classical Hebbian amplitude coding [2]. Namely, by insertion of the eigen wave functions  $\phi^{k_i}$  in the form of modulated plane waves or wavelets [3],

$$\phi^{k_i}(\mathbf{r}, t) = A_{k_i}(\mathbf{r}, t) e^{\frac{i}{\hbar} \alpha_{k_i}(\mathbf{r}, t)} \quad (I.10)$$

the propagator of the quantum system  $S_k$  (I.8) becomes

$$G^k(\mathbf{r}_2, t_2, \mathbf{r}_1, t_1) = \sum_{i=1}^{P_k} A_{k_i}(\mathbf{r}_2, t_2) A_{k_i}(\mathbf{r}_1, t_1) e^{\frac{i}{\hbar} (\alpha_{k_i}(\mathbf{r}_2, t_2) - \alpha_{k_i}(\mathbf{r}_1, t_1))} \quad (I.11)$$

which describes the two-fold memory encoding of the quantum system  $S_k$ : through the amplitude correlation, similarly to Hebbian rule in classical associative neural networks [2],

$$\sum_{i=1}^{P_k} A_{k_i}(\mathbf{r}_2, t_2) A_{k_i}(\mathbf{r}_1, t_1) \quad (I.11')$$

and through the phase differences, similarly to holography [40]:

$$\delta \alpha_{k_i} = \alpha_{k_i}(\mathbf{r}_2, t_2) - \alpha_{k_i}(\mathbf{r}_1, t_1) \quad (I.11'')$$

The correspondence of the informational-physical laws of neural and quantum physics, presented in this appendix, seems to represent only one of illustrations of the *deep fractal interrelations of the laws of Nature* on different levels. It has also been shown recently [42] that physical laws which describe simple clocks, simple computers, black holes, space-time foam, and holographic principle - are interrelated!

## APPENDIX II: QUANTUM DECOHERENCE THEORY AND STATIONARY AND NONSTATIONARY STATES OF A QUANTUM SYSTEM

Simply speaking, a process (effect) of *decoherence* is a physical process "induced" by environment  $E_k$  of  $k$ -th quantummechanical system, leading by unavoidable interaction between environment and quantum system to an effective, approximately *classical-physical behaviour of the quantum system*  $S_k$  [5]. The composite system  $S_k + E_k$ , as the closed quantum system, is subject to the Schrodinger law (although this does not holds true separately for neither  $S_k$  nor  $E_k$ , which are referred to as the *open quantum systems*), with Hamiltonian  $\hat{H} = \hat{H}_{S_k} + \hat{H}_{E_k} + \hat{H}_{\text{int}}$  which exists in the unitary operator of temporal evolution of the composite system:  $\hat{U}(t) = \exp(-2\pi i \hat{H} t / h) \cong \exp(-2\pi i \hat{H}_{\text{int}} t / h)$  (as the interaction Hamiltonian ( $\hat{H}_{\text{int}}$ ) is usually much greater than the "self-Hamiltonian" of the mutually noninteracting system ( $\hat{H}_{S_k}$ ) and environment ( $\hat{H}_{E_k}$ )).

The first task is to calculate the state of the open system  $S_k$ , the so-called "reduced statistical operator"  $\hat{\rho}_{S_k}$ :

$$\hat{\rho}_{S_k}(t) = \text{tr}_E \left( \hat{U}(t) \hat{\rho}_{S_k+E_k}(t=0) \hat{U}^*(t) \right) \quad (\text{II.1})$$

where  $\hat{\rho}_{S_k+E_k}(t=0)$  is the initial state of the composite system  $S_k + E_k$ , while " $\text{tr}_E$ " refers to the integrating over the environmental  $E_k$  degrees of freedom. Further, under the set of the special conditions [43], one can observe the *occurrence of the decoherence effect* defined loosely as:

(i) in the representation of a special orthonormalized basis  $\{ |\phi^{k_i}\rangle_{S_k} \}$  of the Hilbert state space of the system  $S_k$  - the so-called "pointer basis" - one obtains *disappearance of the off-diagonal elements* of  $\hat{\rho}_{S_k}$ :

$$\lim_{t \rightarrow \infty} \rho_{S_k m m'}(t) = 0, \quad m \neq m' \quad (\text{II.2})$$

(ii) with the requirement of *stability ("robustness")* of the elements of the pointer basis:

$$\hat{H}_{\text{int}} |\phi^{k_i}\rangle_{S_k} |\varphi\rangle_{E_k} = |\phi^{k_i}\rangle_{S_k} |\varphi_{k_i}\rangle_{E_k} \quad (\text{II.3})$$

or equivalently

$$\hat{U}(t) |\phi^{k_i}\rangle_{S_k} |\varphi\rangle_{E_k} = |\phi^{k_i}\rangle_{S_k} |\varphi_{k_i}(t)\rangle_{E_k}$$

(II.4)

Then, effectively, there appear the *environment-induced superselection rules (decoherence)*, which *forbid the coherent superpositions of certain states of the system*  $S_k$ . In other words, decoherence *establishes existence and robustness* of a preferred set of states - e.g. of the "pointer basis" - of an open system  $S_k$ .

If the initial state of  $S_k$  is a coherent superposition,  $|\phi^k\rangle_{S_k} = \sum_i c_{k_i} |\phi^{k_i}\rangle_{S_k}$ , then the decoherence process can be presented as:

$$|\phi^k\rangle_{S_k} = \sum_i c_{k_i} |\phi^{k_i}\rangle_{S_k} \xrightarrow{\tau_D} \hat{\rho}_{S_k}^k = \sum_i |c_{k_i}|^2 |\phi^{k_i}\rangle_{S_k} \langle \phi^{k_i}| \quad (\text{II.5})$$

where  $\tau_D$ , the decoherence time, is the order of magnitude of the unfolding of the decoherence process. Eq. (II.5) exhibits the loss of the initial coherence - which justifies the term *decoherence* [5].

The further task is the proper modelling of the interaction Hamiltonian,  $\widehat{H}_{\text{int}}$ , in order to deduce (i) and (ii), i.e. Eq. (II.5) for the composite system  $S_k + E_k$ . Without employing any details, we emphasise that that virtually independently on the model of the environment  $E_k$ , the following simplest separable interaction Hamiltonian fulfils our requirements (being necessary condition for decoherence effect) [43]:

$$\widehat{H}_{\text{int}} = C\widehat{S}_k \otimes \widehat{D}_{E_k} \quad (\text{II.6})$$

where  $C$  stands for the coupling constant (determining the strength of interaction),  $\widehat{S}_k = \sum_i k_i |\phi^{k_i}\rangle_{S_k S_k} \langle \phi^{k_i}|$  is the corresponding observable of the system  $S_k$ , and  $\widehat{D}_{E_k}$  is arbitrary observable of the environment  $E_k$ .

Everything presented above referred to *stationary states* established by decoherence process, whose previous condition (ii) tends to freeze dynamics of an open system, once the system is in a "preferred" stationary state.

However, in the case of *nonstationary states* resulted as a consequence of an external action on the composite system  $S_k + E_k$ , the previous stationary state might be firstly broken and afterwards accompanied by re-establishment of the effect of decoherence due to the interaction, Eq. (II.6). In this context, the following *physically and phenomenologically plausible* assumptions can be introduced, generally applicable to any quantum system [44]: (i) the external influence is *much stronger* than the interaction Eq. (II.6), and (ii) *after* the external action, the composite system relaxes to equilibrium (a stationary state) due to the interaction Eq. (II.6).

Hence, we have the following physical situation: *initially*, the composite system  $S_k + E_k$  is in a "stationary state":

$$\widehat{\rho}_{S_k}^k = \sum_i |c_{k_i}|^2 |\phi^{k_i}\rangle_{S_k S_k} \langle \phi^{k_i}| \quad (\text{II.7})$$

Then, the *strong external action* generally noncommuting with  $\widehat{H}_{\text{int}}$ , Eq. (II.6), redefines the environment  $E_k'$  during the time  $T_{\text{ext}}$ , giving rise to the following nonstationary state transformation for the system  $S_k$ :

$$\widehat{\rho}_{S_k}^k \rightarrow \widehat{\rho}_{S_k}^{k'} \quad (\text{II.8})$$

such that, *in general*:

$$[\widehat{\rho}_{S_k}^k, \widehat{\rho}_{S_k}^{k'}] \neq 0 \quad (\text{II.9})$$

Next, *after the external action*, the composite system  $S_k + E_k'$  is subject to the nonstationary *relaxation process* of the duration  $T_{\text{rel}}$ , which in general gives rise to another state change of  $S_k$ :

$$\widehat{\rho}_{S_k}^{k'} \rightarrow \widehat{\rho}_{S_k}^{k''} \quad (\text{II.10})$$

Finally, the relaxation process *re-establishes* the stationary state and interaction defined by Eq. (II.6), which *guarantees existence and stability of the stationary states of the system  $S_k$* , giving rise to its final state [43,44]:

$$\widehat{\rho}_{S_k}^{k'''} = \sum_i w_i \left| \phi^{k_i} \right\rangle_{S_k S_k} \left\langle \phi^{k_i} \right| \quad (\text{II.11})$$

during the decoherence time  $\tau_D$ , of the transition  $\widehat{\rho}_{S_k}^{k''} \rightarrow \widehat{\rho}_{S_k}^{k'''}$ .

The difference between initial  $\widehat{\rho}_{S_k}^k$  and final  $\widehat{\rho}_{S_k}^{k'''}$  should be pointed out. Both states refer to the stationary states  $\left| \phi^{k_i} \right\rangle_{S_k}$ , guaranteeing their existence and stability. However, the relative contribution of different states - i.e. their "statistical weights" - is different,  $w_{k_i} \neq |c_{k_i}|^2$ . *In effect*, there has occurred the *state change of system  $S_k$* , i.e. the shape change of the potential hypersurface in the energy-state space of the system  $S_k$ , cf. Fig. 1.

The total duration of the nonstationary state change of the quantum system  $S_k$  reads:

$$T = T_{ext} + T_{rel} + \tau_D \quad (\text{II.12})$$

As the process of quantum decoherence is enormously fast (for manyparticle systems  $\tau_D \ll 10^{-23}$  s [5]),

$$T_{ext} + T_{rel} \gg \tau_D \quad (\text{II.13})$$

then the *duration of the state change of the quantum system  $S_k$  in our model is of the order  $T_{ext} + T_{rel}$* , i.e. determined by the duration of classical macroscopic processes of the external action and relaxation of the system.

It should be pointed out that the proposed quantum-decoherence model might be *generally applied* on any quantum system and its stationary states and excitations, from macromolecules and its conformations [44] to acupuncture system and its psychosomatic states (considered in Ch. 3, in the context of two cognitive modes of consciousness). So, for instance, during application of *MRT therapy* for transferring disordered *acupuncture system  $S_k$*  from the psychosomatically excited state  $\left| \phi^{k_2} \right\rangle_{S_k}$  into the healthy ground state  $\left| \phi^{k_0} \right\rangle_{S_k}$  (cf. Fig. 1), it is necessary during the strong external action ( $T_{ext}$ ) to provide external microwave energy for skipping over potential barrier of the disordered state ( $\Delta E_{S_k}^{k_2,0}$ ), which after relaxation process ( $T_{rel}$ ) of taking-off the excess external energy ( $\Delta E_{S_k}^{k_0,2}$ ), gives rise to condition of the completed quantum state change of the acupuncture system  $\widehat{\rho}_{S_k}^k \rightarrow \widehat{\rho}_{S_k}^{k'''}$ , with additional decoherence time ( $\tau_D$ ) and decrease of one quantum of microwave energy in the state  $\left| \phi^{k_2} \right\rangle_{S_k}$  and increase of one quantum of microwave energy in the state  $\left| \phi^{k_0} \right\rangle_{S_k}$  ! By multiple repeating of this process, the depth of the memory attractor  $k_2$  is getting shallower while the depth of the memory attractor  $k_0$  is getting deeper, finally giving rise to complete erasing of the psychosomatic disorder  $\left| \phi^{k_2} \right\rangle_{S_k}$  and deepening of the healthy state  $\left| \phi^{k_0} \right\rangle_{S_k}$ , i.e. *dynamic modification of the potential hypersurface of the acupuncture system*, in full analogy with the situation of learning classical Hopfield associative neural networks [2], cf. Fig. 1.

Finally, it should be added in the context of necessary conditions for decoherence process [43], that defining of open quantum system and its environment is a simultaneous process - implying that, within the context of universality of quantum mechanics, *consciousness is only relative concept*, nonlocally defined with all distant parts of the existing observed Universe (and vice versa!) [45] - which is in accordance with the idea of collective consciousness as a possible ontological property of the physical field itself, with various microquantum and macroquantum (both nonbiological and biological) excitations (cf. Ch. 2) [27].

## REFERENCES

1. K.R. Popper, J.C. Eccles; *The Self and Its Brain*; Springer, Berlin, 1977, Chs. E2,3; B.J. Baars; *A Cognitive Theory of Consciousness*; Cambridge Univ. Press, Cambridge, MA, 1988; F. Crick; *The Astonishing Hypothesis: The Scientific Search for the Soul*; Charles Scribner's Sons, New York, 1994; D. Raković, Dj. Koruga (editors); *Consciousness: Scientific Challenge of the 21st Century*; ECPD, Belgrade, 1995; D. Raković; *Fundamentals of Biophysics*; Grosknjiga, Beograd, 1995, Chs. 5-6.
2. J.J. Hopfield; Neural networks and physical systems with emergent collective computational abilities; *Proc. Natl. Acad. Sci. USA*, Vol. 79, pp. 2554-2558, 1982; T. Kohonen; *Self-Organization and Associative Memory*; Springer, Berlin, 1984; D. Amit; *Modeling Brain Functions: The World of Attractor Neural Nets*; Cambridge Univ. Press, Cambridge, MA, 1989; H. Haken; *Synergetic Computers and Cognition (A top-Down Approach to Neural Nets)*; Springer, Berlin, 1991; and references therein.
3. M. Peruš; Neuro-quantum parallelism in mind-brain and computers; *Informatica*, Vol. 20, pp. 173-183, 1996; M. Peruš, S.K. Dey; Quantum systems can realize content-addressable associative memory; *Appl. Math. Lett.*, Vol. 13, pp. 31-36, 2000; M. Peruš; Multi-level synergetic computation in brain; *Nonlinear Phenomena in Complex Systems*, Vol. 4, pp. 157-193, 2001; M. Peruš, H. Bischof; Quantum-wave pattern recognition: from simulations towards implementation; in K. Chen et al. (editors); *Proc. 7<sup>th</sup> Joint Conf. Information Sciences*; JCIS/Association for Intelligent Machinery, Durham, NC, 2003; M. Peruš, H. Bischof, L.C. Kiong; Quantum-implemented selective reconstruction of high-resolution images; <http://www.arxiv.org/abs/quant-ph/0401016>, 2004; and references therein.
4. S.R. Hameroff; Quantum coherence in microtubules: a neural basis for emergent consciousness?; *J. Consciousn. Stud.*, Vol. 1, pp. 91-118, 1994; Dj. Koruga; Information physics: In search of a scientific basis of consciousness, in D. Raković, Dj. Koruga (editors), *Consciousness: Scientific Challenge of the 21st Century*; ECPD, Belgrade, 1995, 1996.
5. D. Giulini, E. Joos, C. Kiefer, J. Kupsch, I.-O. Stamatescu, H.D. Zeh; *Decoherence and the Appearance of a Classical World in Quantum Theory*; Springer, Berlin, 1996.
6. J. von Neumann; *Mathematical Foundations of Quantum Mechanics*; Princeton Univ. Press, Princeton, NJ, 1955.
7. H.P. Stapp; Quantum theory and the role of mind in nature, *Found. Phys.*, Vol. 31, pp. 1465-1499, 2001; H. Stapp; *Mind, Matter, and Quantum Mechanics*; Springer, New York & Berlin, 1993.
8. D. Raković; Brainwaves, neural networks, and ionic structures: Biophysical model for altered states of consciousness; in D. Raković, Dj. Koruga (editors); *Consciousness: Scientific Challenge of the 21st Century*; ECPD, Belgrade, 1995; D. Raković; Prospects for conscious brain-like computers: Biophysical arguments; *Informatica (Special Issue on Consciousness as Informational Phenomenalism)*, Vol. 21, pp. 507-516, 1997; D. Raković; Transitional states of consciousness as a biophysical basis of transpersonal transcendental phenomena; *Int. J. Appl. Sci. & Computat.*, Vol. 7, pp. 174-187, 2000; and references therein.
9. C. Tart (editor); *Altered States of Consciousness*; Academic, New York, 1972.
10. A. Shimony, in R. Penrose, A. Shimony, N. Cartwright, S. Hawking (editors); *The Large, the Small and the Human Mind*; Cambridge Univ. Press, Cambridge, 1995.
11. N.P. Zalyubovskaya; *An Estimation of Effects of Millimeter and Submillimeter Microwaves upon Various Biological Objects*; M.S. Thesis in Biological Sciences; Kharkov State University, 1970, in Russian; N.D. Devyatkov; Influence of the millimeter wavelength range electromagnetic radiation upon biological objects; *Soviet Physics - Uspekhi*, Vol. 110, pp. 452-454, 1973; see also pp. 455-469 in this volume; N.D. Devyatkov, O. Betskii (editors); *Biological Aspects of Low Intensity Millimeter Waves*; Seven Plus, Moscow, 1994.
12. Ye.A. Andreyev, M.U. Bely, S.P. Sit'ko; *Manifestation of characteristic eigenfrequencies of human organism*; Application for the Discovery to the Committee of Inventions and Discovery at the Council of Ministers of the USSR, No. 32-OT-10609, 22 May 1982, in Russian; S.P. Sit'ko, Ye.A. Andreyev, I.S. Dobronravova; The whole as a result of self-organization; *J. Biol. Phys.*, Vol. 16, pp. 71-73, 1988; S.P. Sit'ko, V.V. Gzhko; Towards a quantum physics of the living state; *J. Biol. Phys.*, Vol. 18, pp. 1-10, 1991; S.P. Sit'ko, L.N. Mkrtchian; *Introduction to Quantum Medicine*; Pattern, Kiev, 1994.
13. M. Tegmark; Importance of quantum decoherence in brain processes; *Phys. Rev. E*, Vol. 61, pp. 4194-4206, 2000.
14. Z. Jovanović-Ignjatić, D. Raković; A review of current research in microwave resonance therapy: Novel opportunities in medical treatment; *Acup. & Electro-Therap. Res., The Int. J.*, Vol. 24, pp. 105-



- 125, 1999; D. Raković, Z. Jovanović-Ignjatić, D. Radenović, M. Tomašević, E. Jovanov, V. Radivojević, Ž. Martinović, P. Šuković, M. Car, L. Škarić; An overview of microwave resonance therapy and EEG correlates of microwave resonance relaxation and other consciousness altering techniques; *Electro- and Magnetobiology*, Vol. 19, pp. 193-220, 2000; D. Raković; Biophysical bases of the acupuncture and microwave resonance stimulation; *Physics of the Alive*, Vol. 9, pp. 23-34, 2001; and references therein.
15. D. Raković, M. Dugić, M.M. Ćirković; Macroscopic quantum effects in biophysics; *Proc. Satell. Symp. Quantum Epoch: 100 Years from the Discovery of Quantum Physics*; Academy of Sciences and Arts of Serbs Republic, Banja Luka, Bosnia and Herzegovina, 2001, in Serbian; D. Raković; Hopfield-like quantum associative neural networks and (quantum)holistic psychosomatic implications; in B. Reljin, S. Stanković (editors); *Proc. NEUREL-2002*; IEEE Yugoslavia Section, Belgrade, 2002; D. Raković; Biophysical bases and frontiers of (quantum)holistic psychosomatics; in V. Jerotić, Dj. Koruga, D. Raković (editors); *Science - Religion - Society*; Theological Faculty of Serbian Orthodox Church & Serbian Ministry of Religions, Belgrade, 2002, in Serbian; D. Raković, M. Dugić; Quantum and classical neural networks for modeling two cognitive modes of consciousness; in I. Kononenko, I. Jerman (editors); *Proc. 6th Int. Multi-Conf. Information Society IS'2003, Mind-Body Studies*; Information Society, Ljubljana, 2003; D. Raković, M. Dugić; Quantum and classical neural networks: Implications for modeling psychosomatic and cognitive functions; in S. Jovičić, M. Sovilj (editors); *Language and Speech: Interdisciplinary Research of Serbian Language I*; IEFPG, Belgrade, 2004, in press.
  16. R.J. Callahan, J. Callahan; *Thought Field Therapy and Trauma: Treatment and Theory*; Indian Wells, CA, 1996; R.J. Callahan; R. Trubo; *Tapping the Healer Within*; Contemporary Books, NY, 2001; R.J. Callahan; The impact of thought field therapy on heart rate variability (HRV); *J. Clin. Psychol.*, Oct. 2001, see also <http://www.interscience.Wiley.com>; Ž. Mihajlović Slavinski; *PEAT and Neutralization of Primeval Polarities*; Belgrade, 2000, in Serbian.
  17. R. Penrose; *The Emperor's New Mind*; Oxford Univ. Press, New York, 1989; R. Penrose; *Shadows of the Mind: A Search for the Missing Science of Consciousness*; Oxford Univ. Press, Oxford, England, 1994; R. Penrose; in M. Longair (editor); *The Large, the Small and the Human Mind*; Cambridge Univ. Press, Cambridge, England, 1997.
  18. M.S. Morris, K.S. Thorne, U. Yurtsever; Wormholes, time machines, and the weak energy condition; *Phys. Rev. Lett.*, Vol. 61, pp. 1446-1449; 1988; M. Visser; Quantum wormholes; *Phys. Rev. D*, Vol. 43, pp. 402-409, 1991; K.S. Thorne; *Black Holes and Time Warps: Einstein's Outrageous Legacy*; Picador, London, 1994, and references therein.
  19. R.G. Jahn, The persistent paradox of psychic phenomena: An engineering perspective, *Proc. IEEE*, Vol. 70, pp. 136-170, 1982, and references therein.
  20. <http://www.dukenews.duke.edu> 1998, 9 Nov.; *News*; Medical Center News Office, Duke University, NC, USA; Results of this feasibility study conducted by the Duke University and Durham Veterans Affairs medical centers - in which angioplasty patients with acute coronary syndromes who were simultaneously prayed for by seven different religious sects around the world did 50 percent to 100 percent better during their hospital stay than patients who were not prayed for by these groups - were intriguing enough to initiate wider investigations in several USA medical centers. Overview of the previous similar studies can be found in the book of L. Dossey; *Healing Words: The Power of Prayer and The Practice of Medicine*; Harper Paperbacks, New York, 1993.
  21. R.J. Jahn, B.J. Dunne; *Margins of Reality*; Harcourt Brace, New York, 1988; and many archival publications and technical reports by PEAR (Princeton Engineering Anomalies Research); see [www.princeton.edu/~pear](http://www.princeton.edu/~pear). The results of these experiments might be interpreted by intentional transitional transpersonal biological (non-Schrödinger governed) quantum-gravitational tunnelling of the operator's individual consciousness with mental addressing on the machine's content of collective consciousness in operator's transitional states of consciousness, thus channelling intentionally the operator/machine composite state of collective consciousness ( $|\Phi\rangle_S \rightarrow |\Phi_i\rangle_S$ ), and automatically influencing the machine output ( $|\Psi\rangle_E \rightarrow |\Psi_i\rangle_E$ ) in the non-Schrödinger quantum-gravitationally governed collapse-like process ( $|\Phi\rangle_S |\Psi\rangle_E = \sum_j a_j |\Phi_j\rangle_S |\Psi_j\rangle_E \rightarrow |\Phi_i\rangle_S |\Psi_i\rangle_E$ ).
  22. W.A. Tiller, W.E. Dibble, Jr., M.J. Kohane; Exploring robust interactions between human intention and inanimate/animate systems; *Ditron Preprint*; presented at *Int. Conf. Toward a Science of*

- Consciousness - Fundamental Approaches*, May 1999, UN Univ., Tokyo, Japan, and references therein.
23. V.P. Kaznacheev, A.V. Trofimov; *Cosmic Consciousness of Humanity*; Elendis-Progress, Tomsk, 1992, and references therein.
  24. K. Wilber; *The Atman Project*; Quest, Wheaton, IL, 1980; P. Vujićin; States of consciousness in esoteric practice, in D. Raković, Dj. Koruga (editors); *Consciousness: Scientific Challenge of the 21st Century*; ECPD, Belgrade, 1995, 1996, and references therein.
  25. J. Vlahos; *Orthodox Psychotherapy: Holy Fathers Science*; Orthodox Missionary School of St. Alexander Nevskiy Church, Belgrade, 1998, Serbian translation from Greek.
  26. M. Eljadi; *Guide through World Religions*; Narodna knjiga - Alfa, Belgrade, 1996, Serbian translation from English.
  27. In approximation of almost non-interacting individual consciousnesses  $|\phi^k\rangle_{S_k}$ , the state of collective consciousness is  $|\Phi\rangle_S \sim \prod_k |\phi^k\rangle_{S_k}$ , and as cosmic collective consciousness, coincident with Universe itself, does not have an (out)cosmic interaction environment  $|\Psi\rangle_E$  which would give rise to decoherence process in interaction with cosmic  $|\Phi\rangle_S$  - hence there is no collapse of the wave function of cosmic collective consciousness, i.e. Universe as a whole! It should be pointed out, in the context of necessary conditions for decoherence process [43], that defining of open quantum system and its environment is a simultaneous process - implying that, within the context of universality of quantum mechanics, consciousness is only relative concept nonlocally defined with all distant parts of the existing observed Universe (and vice versa!) [45], simultaneously providing conditions for the decoherence process in the context of existence of relative borderline: |(partial) individual and collective consciousness $\rangle_S$  (complementary) cosmic environment $\rangle_E$ .
  28. D. Witztum, E. Rips, Y. Rosenberg; Equidistant letter sequences in The Book of Genesis; *Statistical Science*, Vol. 9, pp. 429-438, 1994; A popular survey of mathematical discovery of this extraordinary code is given in the books: M.Drosnin; *The Bible Code*; Simon & Schuster, New York, 1997 and M.Drosnin; *Bible Code II: The Countdown*; Viking Penguin, New York, 2002. The fascinating possibility that history of Civilisation is preferentially coded in the Old Testament revealed to Moses on the Mount Sinai 3000 years ago, might be interpreted as a consequence of the quantum-holographic nature of the cosmic collective consciousness (God!?) and its every original manifestation (including The Old Testament, as well as every individual consciousness) - which still does not mean the strict determinism of the History by the existing state of collective consciousness, whose memory attractors could be reprogrammed by merciful prayer for the others thus removing interpersonal loads of the quantum-holographic neural network of collective consciousness - so leaving the room for free will and influence on the future preferences [8,15].
  29. N. Berdjajev; *Philosophy of Freedom*; Logos Ant, Belgrade, 1996, Serbian translation from Russian.
  30. This might be supported by so called Pulse diagnostics based on 20 pulses in Tibetan Medicine, enabling precise diagnosis of psychosomatic disorders not only of the patient himself but also of his family members and enemies, closely interrelated with him on the level of collective consciousness; see S. Petrović; *Tibetan Medicine*; Narodna knjiga - Alfa, Belgrade, 2000, in Serbian. Global frontiers of holistic psychosomatics are further supported by the practice of Tibetan medicine that in terminal phases, when even meditation accompanied with prayers is not helpful, life of the dying person might be prolonged, for instance, by returning the hunted fish in the river (presumably as a part of redistribution of mental loads on the level of collective consciousness). On the similar contemporary holistic experiences, see the book S.N. Lazarev; *Diagnostics of Karma (book one), System of the Field Self-Regulation*; DI Konstanta, Belgrade, 1995, Serbian translation from Russian, according to which karma should be interpreted as psychosomatic loads transpersonally transferred between the relatives and enemies, similarly to Christian concept of sin.
  31. S. Milenković; *Values of Contemporary Psychotherapy*; Narodna knjiga - Alfa, Belgrade, 1997, in Serbian.
  32. J.S. Hagelin; Is consciousness the unified field? A field theorist's perspective; *Modern Sci. & Vedic Sci.*, Vol. 1, pp. 29-88, 1987, and references therein.
  33. Popular survey of the mentioned Russian research is given in the book G. von Fosar, F. Bludorf; *Vernetzte Intelligenz*; ISBN 3930243237; see also the short survey, DNA's hyper communication: The

- "Living Internet" inside of us, <http://www.fosar-bludorf.com>. On fractal-information coupling of different hierarchical levels in Nature, see also articles: M. Rakočević, The universal consciousness and the universal code; and Dj. Koruga, Information physics: In search of a scientific basis of consciousness, in D. Raković, Dj. Koruga (editors), *Consciousness: Scientific Challenge of the 21st Century*; ECPD, Belgrade, 1995; 1996; as well as the book P. Plichta; *God's Secret Formula*; Element Books, Shaftesbury, 1997.
34. D. Djordjević; *Electrophysiological Research of Reflexotherapy Mechanisms*, M.Sc. Thesis in Medicine; University of Belgrade, 1995, in Serbian, Chs. 1.2 and references therein.
  35. D. Raković, M. Dugić; A critical note on the role of the quantum mechanical "collapse" in quantum modelling of consciousness; *Informatica*, Vol. 26, pp. 85-90, 2002.
  36. R. Broughton; Human consciousness and sleep/waking rhythms; in B.B. Wolman and M. Ulman (editors); *Handbook of States of Consciousness*; Van Nostrand Reinhold, New York, 1986.
  37. D. Raković; Hierarchical neural networks and brainwaves: Towards a theory of consciousness; in Lj. Rakić, G. Kostopoulos, D. Raković, Dj. Koruga (editors), *Brain and Consciousness: Proc. ECPD Workshop*; ECPD, Belgrade, 1997; D. Raković; On brain's neural networks and brainwaves modeling: Contextual learning and psychotherapeutic implications; in B. Lithgow, I. Cosic (editors); *Biomedical Research in 2001: Proc. 2nd IEEE/EMBS (Vic)*; IEEE/EMBS Victorian Chapter, Melbourne, Australia, 2001; D. Raković; Thinking and language: Maturation of EEG and model of contextual language learning; in M. Sovilj, P. Marković, S. Jovičić, A. Kostić, D. Raković (editors); *Speech and Language*; IEFPG, Belgrade, 2003.
  38. J.D. Bjorken, S.D. Drell; *Relativistic Quantum Mechanics (Vol. I)/ Relativistic Quantum Fields (Vol. II)*; McGraw-Hill, New York, 1964/1965; R.P. Feynman, A.R. Hibbs; *Quantum Mechanics and Path Integrals*; McGraw-Hill, New York, 1965.
  39. H. Haken; *Synergetic Computers and Cognition: A Top-Down Approach to Neural Nets*; Springer, Berlin, 1991.
  40. J.G. Sutherland; Holographic model of memory, learning and expression, *Int. J. Neural Sys.*, Vol. 1, pp. 256-267, 1990.
  41. D. Deutch; Quantum theory, the Church-Turing principle and the universal quantum computer; *Proc. Roy. Soc. A*, Vol. 400, pp. 97-117, 1985.
  42. Y.J. Ng; From computation to black holes and space-time foam; *Phys. Rev. Lett.*, Vol. 86, pp. 2946-2949, 2001.
  43. M. Dugić; On diagonalization of the composite-system observable separability; *Phys. Scripta*, Vol. 56, pp. 560-565, 1997; M. Dugić; *A Contribution to Foundation of Decoherence Theory in Nonrelativistic Quantum Mechanics*, Ph.D Thesis in Physics; University of Kragujevac, 1997, in Serbian.
  44. D. Raković, M. Dugić, M. Plavšić; The polymer conformational transitions: A quantum decoherence theory approach; *Materials Science Forum*, Vols. 453-454, pp. 521-528, 2004.
  45. M. Dugić, D. Raković, M.M. Ćirković; On a physical metatheory of consciousness; in I. Kononenko (editor); *Proc. 3rd Int. Multi-Conf. Information Society IS'2000, New Science of Consciousness*; Information Society, Ljubljana, Slovenia, 2000; M. Dugić, M.M. Ćirković, D. Raković; On a possible physical metatheory of consciousness; *Open Systems and Information Dynamics*, Vol. 9, pp. 153-166, 2002.
  46. K.H. Pribram; *Languages of the Brain*; Brooks/Cole, Monterey, CA, 1977, 2nd ed.